(12) UK Patent Application (19) GB (11) 2 310 793 (13) A

(43) Date of A Publication 10.09.1997

(21) Application No 9704615.5

(22) Date of Filing 06.03.1997

(30) Priority Data
(31) 9604734 (32) 06.03.1996 (33) GB

(51) INT CL[6]
B01F 7/24 , A01F 29/00

(52) UK CL (Edition O )
A4C CUG C129

(56) Documents Cited
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(58) Field of Search
UK CL (Edition O ) A4C CA CB CPA CUC CUG CUH CUW
INT CL[6] A01F 29/00 29/02 , B01F 7/00
Online W.P.I.

(71) Applicant(s)
Shelbourne Reynolds Engineering Limited

(Incorporated in the United Kingdom)

Shepherds Grove, Stanton, Bury St Edmunds, Suffolk, IP31 2AR, United Kingdom

(72) Inventor(s)
John Walton

(74) Agent and/or Address for Service
Mewburn Ellis
York House, 23 Kingsway, LONDON, WC2B 6HP, United Kingdom

# (54) Mixing apparatus

(57) A fodder mixing and chopping apparatus has a vertical auger (8) sweeping a central cylindrical space in a downwardly tapering container (2) and driving the fodder upwards in the container. Cutting and agitating means (10,12,14,16) rotating with the auger extend into an annular space outwards of the auger adjacent the container bottom wall. Further cutting means in the form of knife blades (22) project outwardly of the auger at higher levels. The fodder descends through in the outer peripheral region of the container beyond the auger in a circulating flow is urged upwards by the agitating means at the bottom of the container as it passes through the zones of action of the cutting means in this region. Vanes (32) mounted at the inner periphery of the container can be deployed to restrain the container contents from rotating with the auger.

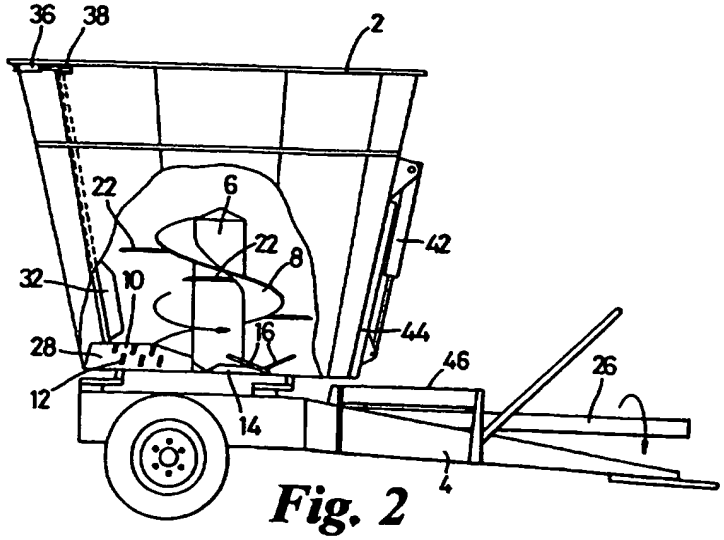


*Fig. 2*

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

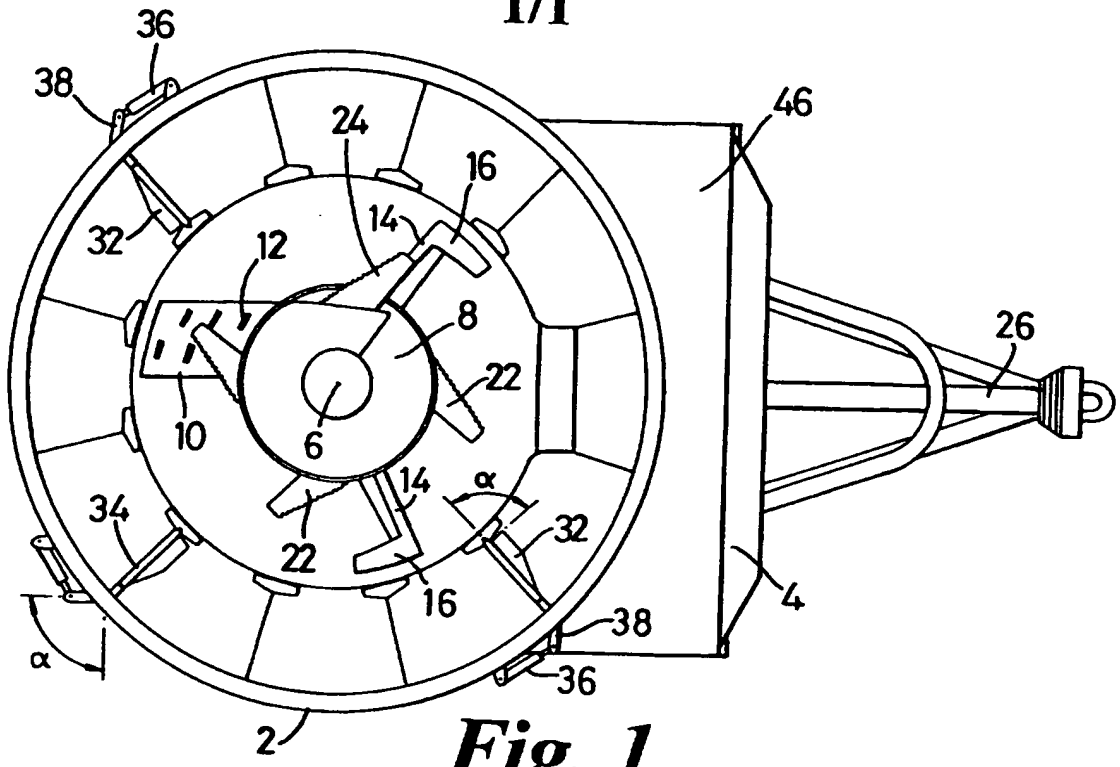
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Fig. 1

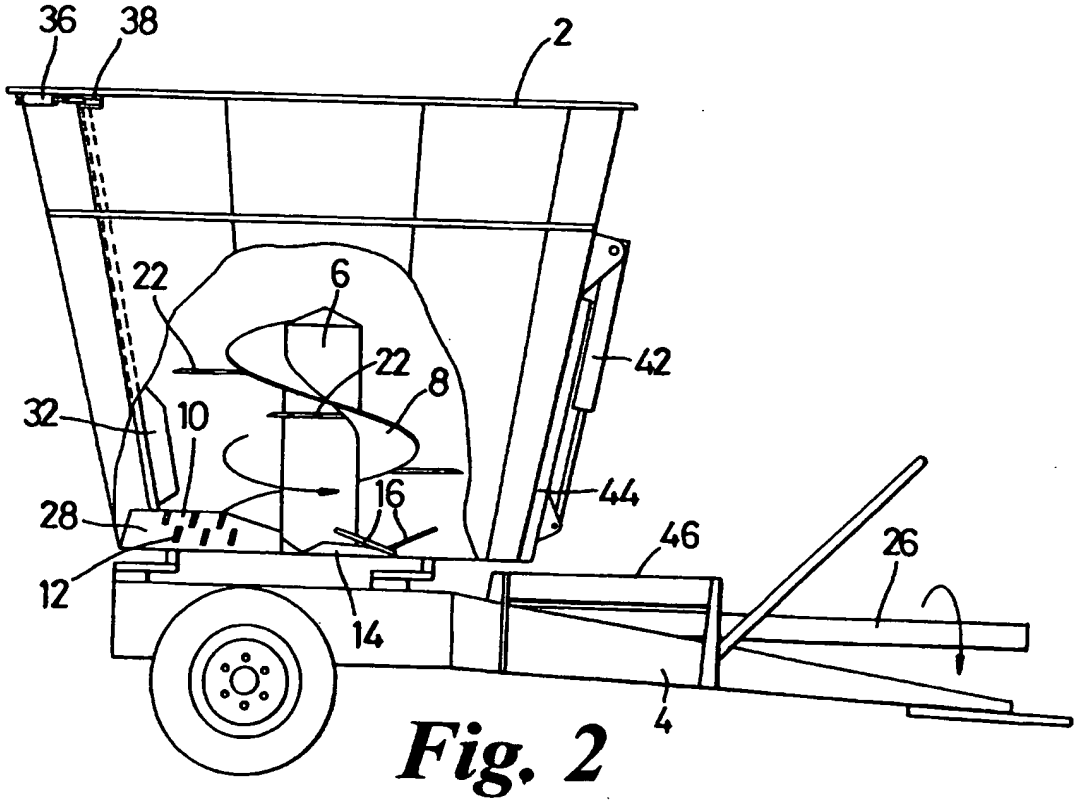
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Fig. 2

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# MIXING APPARATUS

This invention relates to mixing apparatus. It is particularly concerned with mixing apparatus for agricultural purposes, eg. for chopping and mixing fodder, but it is not necessarily so limited.

One known type of mixing machine for fodder such as silage or straw is in the form of an upwardly open container in which a vertical mixing auger is centrally mounted, the container tapering downwards and the auger having a swept volume that tapers upwards from the bottom of the container where it extends over substantially the entire bottom surface of the container. Material caught by the auger is driven upwards with the aim of creating a circulation of the material in the container. In its narrower upper region the auger has horizontally extending knives to chop the material being mixed as it is lifted by the auger to the free space in the upper region of the container.

It is difficult to obtain a uniform product from these machines, due at least in part to the random movement of the container contents which lead to imprecise cutting patterns. The cutting and mixing action may also be adversely affected by a tendency of the contents to rotate with the auger. A further drawback of this type of machine is its relatively high power requirement.

According to the present invention there is provided mixing apparatus comprising a container and a

mixing rotor located centrally within the container with an upwardly extending axis of rotation, said rotor comprising an auger projecting upwards from a central region of the bottom wall of the container, the auger being arranged to drive material being mixed upwards and agitating means extending radially outwards of the auger adjacent said bottom wall to urge material beyond the auger upwards.

In this arrangement, there is a space between the auger, which may sweep a cylindrical volume, and the container sidewalls at the bottom of the container, and the agitating means project into that space to assist the movement of the material.

Said agitating means for the material in the container may comprise at least one arm mounted on the rotor to project outwardly of the auger and having a deflecting surface for lifting the material as the rotor turns. Said deflecting surface preferably extends adjacent to a junction between the container bottom wall and a side wall projecting upwardly therefrom, and preferably also passes close to an outlet from the container.

Preferably cutting means are also provided in said space at the bottom of the container. The cutting means may comprise a plurality of knife elements projecting upwards from one or more arms extending into said space at the bottom of the container. The knife elements may be arranged to be replaceable and/or adjustable to vary the spacing between them.

The or each arm carrying the knife elements may

have a face which is inclined upwards and rearwards relative to its direction of rotation so as to act as said agitating means, and the knife elements may project from that inclined face.

The apparatus may also have, on the rotor, intermediate the height of the auger cutting means with cutting surfaces that extend outwardly away from the axis of rotation, preferably extending generally horizontally.

The volume swept by the auger is confined to a central region of the container preferably leaving an annular space with a radial width not substantially less than the radius of the auger itself. The further cutting means referred to above may project from the radially outer region of the auger and may comprise a plurality of blades at spaced heights.

An embodiment of the invention will be described by way of example with reference to the accompanying drawings, in which:

Figs. 1 and 2 are a partly broken-away side view and a top plan view of a fodder mixing apparatus according to the invention.

The apparatus comprises a substantially frusto-conical mixing container 2, mounted on a trailer chassis 4. The container peripheral wall is composed of a series of flat panels to give it a regular polygonal form. From the centre of the container bottom wall a vertical rotor shaft 6 projects with an auger flight 8 fixed to its periphery. Immediately adjacent the bottom wall, there projects

outwardly from the shaft at approximately equal angular intervals, a carrier arm 10 from an upper face of which a series of knife elements 12 project substantially vertically, and two agitator arms 14 comprising paddles 16 at their outer ends, close to the container side walls. Both the carrier arm 10 and the paddles 16 have upper faces inclined rearwards and upwards in the direction of travel, urging upwardly the material through which they pass.

A series of cutter blades 22 project horizontally and outwardly from the auger flight 8 at positions spaced apart both angularly and vertically. Four equispaced blades 22 are shown, with the cutting edges 24 swept back from the direction of rotation. The blades circulate at a considerable spacing from the container side walls, being shorter than the arms 10,14.

The rotor is driven by a power-take-off shaft 26 to rotate anti-clockwise as seen from above. The auger flight 8 thus drives material upwards, away from the arms 10,14 at the bottom of the container, so fresh material will be drawn by gravity into the zone of action of the arms from the annular region outside the path of the auger. The blades 22 cut through descending material to break up larger masses before they reach the bottom of the container. At the bottom, the knife elements 12 chop the material, which is also agitated by the inclined paddles 16 that trail rearwards from the agitator arms 14 as well as by the inclined face 28 the cutter carrier arm 10.

Because the descending material is spaced from

the auger it settles under gravity and it will be more densely packed than the material being lifted by the auger. The inclined upper faces of the carrier arm 10 and the paddles 14 urging the settling material upwards increase the density of the material in this region. A relatively efficient cutting action can therefore be maintained by the knife elements.

It is possible that under some conditions the material in the container will tend to rotate with the auger, so that the mixing and cutting actions are impaired. To prevent that happening, one or more anti-rotation vanes 32 may be provided at the inner peripheral wall of the container immediately above the agitating means 10,14. Three angularly spaced anti-rotation vanes are shown in the illustrated example each with a corresponding operating mechanism.

Each vane 32 is mounted on a pivot shaft 34 located in rotary mountings (not shown) to extend close to the top of the container. Normally the vanes will lie against the container wall to reduce the power requirement of the apparatus. Because the wall has a polygonal periphery, each vane can lay flat against an adjacent wall panel. To deploy the vane the shaft is rotated by a hydraulic cylinder 36 connected to the shaft by a torque link 38 extending through an aperture in the container wall.

The vanes are pivoted inwards by the hydraulic cylinders 36 when they are required to brake rotation of

the material being mixed. Fig. 1 indicates a maximum pivoting angle $\alpha$ of approximately 90°. Preferably, the vanes are spring-loaded, as by a resilient connection (not shown) in or to their pivot shafts, so that if subjected to an overload they will pivot towards the container wall independently of the setting of the hydraulic cylinders 36.

The vanes 32 are located near the bottom of the container where they will have the greatest effect against rotation of the material, although they will offer little or no resistance to the downwards circulation of material past them over their range of movement. The hydraulic operating mechanisms 36,38 are located at the top of the container, and in particular the cylinders 36 are placed outside the containers, so as to minimise any risk of damage from the material being mixed and to maintain the integrity of the container against leakage of material.

When sufficiently mixed, the material in the container can be discharged by operating a hydraulic ram 42 to lift container door 44 and allow the material to spill onto a conveyor 46, which can be driven in either direction to off-load it. The paddles 16, passing close to the door 44, assist the discharge of the material.

The relatively small diameter of the auger in relation to the container reduces the power requirement and also permits an orderly circulation of the material in the container. The knife elements 12 give an intense cutting action which will tend to size leaf and stem fodder in dependence upon the spacing between the elements. Because

of this, it may be arranged that the final particle size is controlled by changing the spacing of the elements. For example, the elements may be held on the arm 10 in adjustable fixings or alternative fixings can be provided at different spacings on the arm.

It is possible to provide an apparatus with more than one cutter arm carrying knife elements in the lower region of the container. If the arm or at least one cutter arm is itself shaped to lift and agitate the material being mixed, as in the illustrated example, it may be possible to dispense with the agitator arms 14 with their paddles 16, or have a single such agitator arm.

CLAIMS

1. Mixing apparatus comprising a container and a mixing rotor located centrally within the container with an upwardly extending axis of rotation, said rotor comprising an auger projecting upwards from a central region of the bottom wall of the container, the auger being arranged to drive material upwards, and agitating means extending radially outwards of the auger adjacent said bottom wall to urge the material beyond the auger upwards.

2. Mixing apparatus according to claim 1 wherein the auger sweeps a substantially cylindrical volume.

3. Mixing apparatus according to claim 1 or claim 2 wherein the container is downwardly tapering.

4. Mixing apparatus according to any one of claims 1 to 3 wherein, between the lower region of the auger and the container walls, there is an annular space having a radial width not substantially less than the radius of the auger at said region.

5. Mixing apparatus according to any one of the preceding claims wherein the agitating means comprises at least one arm projecting from the shaft close to the container bottom wall and having a deflecting surface for performing a lifting movement of the material being

processed as the shaft rotates.

6. Mixing apparatus according to claim 5 wherein the or at least one said agitating means arm extends adjacent to a junction between the container bottom wall and a side wall projecting upwardly therefrom.

7. Mixing apparatus according to claim 5 or claim 6 wherein the or at least one said agitating means arm extends close to an outlet from the container.

8. Mixing apparatus according to any one of the preceding claims wherein cutting means are provided in a region of the container extending radially outwards of the auger adjacent said bottom wall.

9. Mixing apparatus according to any one of claims 5 to 7 together with claim 8 wherein the or each said arm of the cutting means has a face which is inclined upwards and rearwards relative to its direction of rotation and forms said or at least one arm of the agitating means.

10. Mixing apparatus according to claim 8 or claim 9 wherein said cutting means comprise a plurality of knife elements projecting upwards from one or more arms extending radially outwards of the auger.

11. Mixing apparatus according to claim 9 together

with claim 10 wherein the knife elements project from said inclined face of the or least one said arm.

12. Mixing apparatus according to claim 10 or claim 11 wherein the knife elements are arranged to be replaceable and/or adjustable to vary the spacing between them.

13. Mixing apparatus according to any one of the preceding claims wherein above said cutting and/or agitating means adjacent the container bottom wall, there are upper cutting means with cutting surfaces that extend outwardly from the auger.

14. Mixing apparatus according to claim 13 wherein said cutting surfaces extend generally horizontally.

15. Mixing apparatus according to claim 13 or claim 14 wherein said upper cutting means comprises a plurality of blades at spaced heights on the rotor.

16. Mixing apparatus according to any one of the preceding claims comprising at least one vane element mounted adjacent the peripheral inner wall of the container and displaceable to and from a position projecting inwardly from said wall to restrain rotation of material in the container.

17. Mixing apparatus comprising a container and a mixing rotor located centrally within the container with an upwardly extending axis of rotation, said rotor comprising an auger projecting upwards from a central region of the bottom wall of the container, the auger being arranged to drive material upwards and an annular space surrounding the auger for the recirculation of the material driven upwards thereby, there being at least one vane element mounted within the container adjacent the peripheral inner wall and being displaceable to and from a position projecting inwardly from said wall to restrain rotation of material in the container.

18. Mixing apparatus according to claim 17 wherein said at least one vane element is pivotable to and from said projecting position.

19. Mixing apparatus according to any one of claims 16 to 18 wherein the or each said vane element extends to adjacent the container bottom wall and has an operating shaft extending to adjacent the top of the container.

20. Mixing apparatus according to claim 19 wherein actuating mechanism for the or each said shaft is located externally of the container.

21. Mixing apparatus according to any one of claims 16 to 20 wherein resilient means act on the or each said

vane to allow the vane to be deflected towards the container peripheral wall by a load on it from the material in the container exceeding a predetermined limit.

22. Mixing apparatus constructed and arranged for use and operation substantially as described herein with reference to the accompanying drawings.

The Patent Office

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**Application No:** GB 9704615.5 **Examiner:** R.B.Luck
**Claims searched:** 1-16 **Date of search:** 16 April 1997

## Patents Act 1977
## Search Report under Section 17

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): A4C CA,CB,CPA,CUC,CUG,CUH,CUW.

Int Cl (Ed.6): A01F 29/00,29/00B,29/02,29/02B.B01F 7/00B3,7/00C

Other: Online W.P.I.

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | | Relevant to claims |
|---|---|---|---|
| X | GB1417621 | Sunbeam Corporation.(See particularly Fig 5) | 1 at least |
| X | EP0704153 | T.Faccia | 1 at least |
| X | EP0527428 | T.Faccia | 1 at least |
| X | EP0393583 | T.Faccia | 1 at least |

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